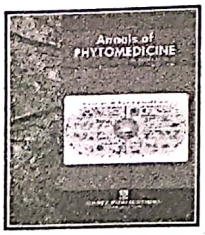
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# Diosgenin: Botanical origins, pharmacological promise, nutraceutical innovations and industrial exploitation

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**Abstract**

Diosgenin, a naturally occurring spirostanol-type steroidal sapogenin predominantly derived from plant species of the genera *Dioscorea, Trigonella and Smilax*, is one of the most important plant-based precursors used in the semi-synthetic production of steroidal pharmaceuticals. Approximately, 50-60 per cent of commercially produced steroid drugs, including corticosteroids, progesterone derivatives and oral contraceptives, are synthesized from plant steroidal sapogenins such as diosgenin, underscoring its strategic importance in the pharmaceutical industry. Among natural sources, *Dioscorea zingiberensis* C.H. Wright and *Dioscorea deltoidea* Wall., contain 2-6 per cent diosgenin on dry weight basis, whereas fenugreek (*Trigonella foenum-graecum* L.) seeds generally contain 0.1-0.9 per cent, depending on genotype and environmental conditions. Beyond its industrial role, diosgenin has attracted considerable attention due to its diverse pharmacological properties, including antioxidant, anti-inflammatory, antidiabetic, anticancer, cardioprotective, neuroprotective, hepatoprotective and antiosteoporotic activities. These biological effects are primarily mediated through modulation of key molecular signaling pathways such as NF-κB, PI3K/Akt, AMPK, MAPK and Nrf2, which regulate inflammation, oxidative stress, apoptosis and metabolic homeostasis. Experimental studies have demonstrated that diosgenin supplementation at 10-200 mg $kg^{1}$ body weight improves lipid metabolism, insulin sensitivity and antioxidant status, supporting its potential as a nutraceutical for managing metabolic disorders. Recent advances in extraction technologies, including ultrasound-assisted, microwave-assisted and supercritical $CO_2$ extraction, have improved recovery efficiency compared with conventional methods, while chromatographic and spectroscopic techniques such as HPLC, GC-MS and NMR enable precise quantification. The global diosgenin market is valued at approximately USD 100-120 million with an expected growth rate of 5-6 per cent annually, driven by increasing demand for steroid drugs, nutraceuticals and plant derived bioactive compounds. This review summarizes the botanical sources, chemical characteristics, biosynthesis, extraction methods, pharmacological mechanisms, nutraceutical applications and industrial significance of diosgenin and highlights future prospects for sustainable production, enhanced bioavailability and expanded therapeutic utilization.

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